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SENSITIVITY AND PELLETING CHARACTERISTICS OF CERTAIN DESENSITIZED RDX MIXTURES

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U. S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

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SENSITIVITY AND PELLETING CHARACTERISTICS OF CERTAIN DESENSITIZED RDX MIXTURES

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ABSTRACT: The sensitivity of RDX, either pure or desensitized by the addition of small amounts of calcium stearate, magnesium stearate, graphite, or polyisobutylene, is compared with that of tetryl. The sensitivity was measured by both the drop weight test and the gap test. The air gap sensitivity was measured by two series of tests. In one series the end of the donor was bare. In the other series the end of the donor was covered by a thin piece of steel. The gap across which the acceptor could be initiated was much greater when the end of the donor was covered. Tests were made of the resistance of pellets of these materials to abrasion. RDX with the addition of polyisobutylene and either calcium or magnesium stearate was equivalent to tetryl in both the sensitivity and abrasion tests.

Explosives Research Department
U.S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

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Tests which were made as a part of the investigation of the suitability of RDX mixtures as a substitute for tetryl as a booster explosive are described in this report. The work was authorized under Task Assignment NOL-S3-2b-41-1-56. The results reported herein are believed to be reliable and are intended as basis for action.

W. W. WILBOURNE
Captain, USN
Commander

J. E. ABLARD
By direction

CONTENTS

SENSITIVITY AND PELLETING CHARACTERISTICS OF CERTAIN DESENSITIZED RDX MIXTURES

INTRODUCTION

Because of the liability of tetryl to "cook-off" at relatively low temperatures, it is very desirable to find a replacement for use in explosive trains. RDX has better resistance to "cook-off" but is considered by the Navy to be too sensitive for use in leads or boosters when used pure. It is also objectionable since pellets made of pure RDX break up too easily when handled. The addition of a small amount of an inert material can serve as a binder and at the same time reduce the sensitivity to that of tetryl. The addition of two or three per cent of wax serves this purpose. A considerable amount of work has been done on mixtures of this type, references (a) and (b). However some trouble has been experienced with stickiness which causes pellets of this material to be broken as they are being removed from the pelleting machine.

SENSITIVITY TESTS

There are many different types of sensitivity tests each of which measures the sensitivity of the explosive to initiation by one means or another. The two that would seem to be the most applicable here are the drop test which measures the sensitivity of an explosive to handling and a gap sensitivity test which measures its sensitivity to initiation by the detonation of an adjacent explosive charge. The drop test sensitivity was measured on the NOL machine which is described in reference (c). The gap test sensitivity was measured with an arrangement similar to that described in reference (d).

In this form of the gap sensitivity test the acceptor explosive is loaded into a cylindrical piece of metal one inch long and one inch in diameter. The hole into which the explosive is loaded has a diameter of 0.200 inch. This was initiated by a donor of the same diameter containing a column of lead azide one-half inch long. Tests

were made in which the donor and acceptor were separated by an air gap. This air gap was varied and the value for which fifty per cent initiation occured was measured by the Bruceton up-and-down method, reference (e). This was done with the acceptor explosive confined in brass and also in aluminum. The test was repeated using a piece of steel 0.006 inch thick covering the end of the donor explosive. This was also done with brass and aluminum confinement of the acceptor. In the first case the principal method of initiation of the acceptor was probably that of the air shock produced by the detonation of the donor explosive. In the second case the initiation was effected by fragments of the steel which struck the acceptor explosive.

ABRASION TEST

Pellets were made of certain of the more interesting explosives and tested to determine their resistance to abrasion upon handling. These pellets were one-half inch in diameter and one-half inch long and were pressed at ten thousand pounds per square inch. They were weighed on an analytical balance. Then they were placed in a cylindrical cardboard carton similar to that used as an ice cream container and this carton was rotated on its axis for one hour allowing the pellets to roll and tumble against each other. The pellets were again weighed and the per cent loss in weight determined.

EXPLOSIVES TESTED

For reference purposes tests were made with ungraphited tetryl and with army type tetryl. This has a maximum of two per cent total of graphite and some binder such as calcium stearate added to the pure tetryl. No analysis was made of the particular sample used in these tests. Tests were made with different samples of RDX. These included samples produced by Holston Ordnance Works and by the Wabash River Ordnance Works. Also tested were samples of a pelleting grade RDX for which a particular particle size distribution is specified, and a subsieve RDX. The particle size of the subsieve RDX is forty microns or less. Determinations were made of the particle size distribution of the other RDX samples used. The results are given in Table 1.

The sensitivity of RDX, as measured by either the impact machine or the gap test, can be made the same as that of tetryl by the addition of approximately two per cent of some material such as calcium stearate. A small amount of graphite may also be added to act as a lubricant in the pressing mold. The addition of this desensitizer can be a mechanical process. Some recent work has been carried out at the Naval Ordnance Laboratory on a method of adding the desensitizer by precipitating it onto the RDX. In this method RDX is placed in water in which sodium stearate is dissolved. To this mixture calcium chloride is added. The resulting chemical reaction results in the precipitation of calcium stearate on the RDX. The other product of the reaction, sodium chloride or common salt, is washed away with the water. This method should result in coating the RDX particles more evenly than when a mechanical mixture is made. Both types of mixes were used in these tests.

One sample tested was obtained from Olin Mathieson Chemical Corporation. This was a mixture of RDX, graphite, and calcium stearate containing two per cent graphite and between one-fourth and one-half per cent of calcium stearate. A similar composition was mixed at the Naval Ordnance Laboratory using Holston RDX and tested for comparison.

Pellets made with this material were still somewhat too fragile. In order to remedy this situation an investigation was made of the efficacy of polyisobutylene as a binder. A small amount of this material was added to coat the grains of RDX before precipitating the stearate. This method is described in reference (f). Very good pellets can be made of this material, CH-4, but it has unsatisfactory flow properties so that it is not practical for use in automatic pelleting machines. It contains 0.75 per cent polyisobutylene and 1.45 per cent magnesium stearate. CH-4a, for which data are given in Table 2, is similar to CH-4 except that calcium stearate is substituted for the magnesium stearate. More recently a new mixture of this same type, known as CH-6, has been made which has good pelleting properties and improved flow characteristics. This mixture contains 0.5 per cent polyisobutylene, 1.5 per cent calcium stearate, and 0.5 per cent graphite. Tests made with automatic pelleting machines indicate that this material is satisfactory for use with such machines.

DISCUSSION OF RESULTS

The data obtained are given in Table 2. A difference of two or three centimeters between two values in the drop test results can be considered as significant. The results of the air gap test in which the end of the donor was bare are more precise than those obtained when the steel was placed on the end of the donor. This is to be expected since in the latter case initiation depends upon the chance of a fragment striking the acceptor explosive column. The standard deviation of the mean for the tests with the end bare is about five per cent of the mean. This is increased to about fifteen per cent when the end of the donor is covered with steel. The air gap measured for CH-6 appears unduly large when tested with aluminum confinement and with the end of the donor covered. The results in this particular test were very erratic, and the value obtained is therefore doubtful.

The correlation between the sensitivities measured by the impact test and those measured by the air gap tests is not good. For instance, the Olin Mathieson desensitized RDX and the CH-4 have the same sensitivity in the drop test whereas these are the most sensitive and the least sensitive respectively of the entire group as shown by the air gap test.

The high sensitivity shown by the Olin Mathieson RDX in the air gap tests is surprising since it is greater than that of the pure RDX tested. Nothing is known of the sensitivity of the RDX used in making this mixture. The mixture made at the Naval Ordnance Laboratory using similar proportions of graphite and calcium stearate and Holston RDX gave sensitivities quite similar to that of tetryl.

Among the RDX materials, only the CH-4 and CH-6 show a loss in weight in the tumble test which is comparable to that of tetryl. Other RDX mixtures showed a much greater loss in this test.

CONCLUSIONS

The following conclusions may be drawn from the data. First, the impact test cannot be relied upon to give a good measure of sensitivity to initiation across an air

gap. Second, the air gap sensitivity is very greatly increased by a cover on the end of the donor explosive which will produce fragments that serve as a means of transmitting the detonation across the gap. Third, the desensitized RDX containing a small percentage of polyisobutylene has a sensitivity of the same order as that of tetryl. Pellets made of this material withstand the abrasion of the tumbling test as well as do those made of tetryl. Pellets of RDX containing small amounts of calcium stearate and graphite show less resistance to abrasion than the CH-6 type material.

Table 1
Sieve Analysis of RDX Samples

Held on Sieve	RDX Sample Wabash	Holston	Pelleting
100	41.9%	38.9%	78.1%
140	13.3%	21.6%	4.4%
170	10.9%	12.5%	3.3%
200	7.3%	7.8%	1.7%
Pan	26.6%	19.2%	12.5%

Table 2
Results of Sensitivity and Tumbling Test Experiments

	Tumble Test % Loss	Drop Test cm	Air Gap in Inches Donor Bare Confinement Brass	Donor Bare Confinement Aluminum	Donor Covered Confinement Brass	Donor Covered Confinement Aluminum
RDX, Wabash	---	24	0.413	0.355	7.464	7.250
RDX, Holston	---	23	0.318	0.230	6.025	5.094
RDX, Pelleting	8.93	21	0.229	0.146	6.080	3.630
RDX, Subsieve	---	21	0.335	0.304	-----	-----
RDX, Olin Desensitized	8.58	27	0.422	0.413	8.035	6.250
RDX/Graphite/Cal. Stearate	---	28	0.155	0.091	4.400	2.818
RDX/Calcium Stearate 98/2	3.14	31	0.144	0.079	3.845	3.130
CH-4	0.52	27	0.114	0.077	0.842	0.743
CH-4a	0.33	28	0.144	0.089	6.610	3.680
CH-6	0.56	26	0.146	0.088	1.820	3.760
Army Tetryl	0.32	27	0.150	0.093	4.058	2.660
Pure Tetryl	0.42	28	0.184	0.138	3.140	2.585

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